CLAIMS

1. A duplex exchanger comprising:

a first heat exchanger including a first main flow channel and a first counterheat channel joined in flow communication therewith;

a second heat exchanger including a second main flow channel and a second counterheat channel joined in flow communication with said first heat exchanger; and

means for injecting an evaporative coolant into said first counterheat channel.

2. A duplex exchanger according to claim 1 wherein said second counterheat channel is joined in flow communication with said first main channel.

3. A duplex exchanger according to claim 2 further comprising means for injecting an evaporative saturant into said second counterheat channel.

4. A duplex exchanger according to claim 3 wherein said second counterheat channel is additionally joined in flow communication with said first counterheat channel.

5. A method of using said duplex exchanger according to claim 4 comprising:

channeling a hot primary gas stream through said first main channel;

splitting said primary stream into both said first and second counterheat channels,

injecting said evaporative coolant into said first counterheat channel for being evaporated by said hot primary stream flowing through said first main channel, and thereby cooling said primary stream therein;

channeling a hot secondary fluid stream through said second main channel for heating said cooled primary stream in said second counterheat channel; and

injecting said evaporative saturant into said second counterheat channel for being evaporated by said hot secondary stream flowing through said second main channel, and thereby saturating said primary stream discharged through said second counterheat channel.

6. A method according to claim 5 further comprising discharging said primary stream from said first counterheat channel into an intermediate stage of said second counterheat channel.

7. A method according to claim 6 further comprising:

injecting said evaporative saturant along an initial stage of said second counterheat channel; and

superheating said primary stream in said second counterheat channel downstream of said initial stage using heat from said secondary stream channeled through said second main channel.

8. A method according to claim 6 further comprising:

injecting said evaporative coolant along an initial stage of said first counterheat channel; and

superheating said primary stream in said first counterheat channel downstream of said initial stage using heat from said primary stream channeled through said first main channel.

9. A method according to claim 6 further comprising injecting excess evaporative coolant into said first counterheat channel for cooling thereof, and removing said cooled excess evaporative coolant from said first heat exchanger.

10. A duplex exchanger according to claim 4 wherein:

said first heat exchanger includes a bank of first tubes collectively defining said first main channel supported in a plurality of alternating first baffles collectively defining said first counterheat channel around said first tubes; and

said second heat exchanger includes a bank of second tubes collectively defining said second main channel supported in a plurality of second baffles collectively defining said second counterheat channel around said second tubes.

11. A duplex exchanger according to claim 10 further comprising a septum separating said

first and second heat exchangers for controlling flow therebetween.

12. A duplex exchanger according to claim 11 wherein said first heat exchanger is disposed in a first tubular shell and said second heat exchanger is disposed in a second tubular shell, and said shells provide a double septum therebetween.

13. A duplex exchanger according to claim 11 wherein both said first and second heat exchangers are disposed in a common tubular shell, and said septum divides said shell into two corresponding compartments for said heat exchangers.

14. A duplex exchanger according to claim 11 wherein said first and second tubes include external fins for increasing wetting surface area thereof for said evaporative coolant and saturant.

15. A duplex exchanger according to claim 11 wherein:

said first heat exchanger includes a first inlet at a forward end for providing said primary stream to said first tubes, a first outlet at an opposite aft end for discharging a first portion of said primary stream from said first tubes, and a second outlet disposed between said first inlet and outlet for discharging a second portion of said primary stream from said first counterheat channel; and

said second heat exchanger includes a first inlet at a forward end for providing said secondary stream to said second tubes, a first outlet at an opposite aft end for discharging said secondary stream from said second tubes, a second outlet adjacent said first inlet thereof for discharging said primary stream from said second counterheat channel, and a second inlet adjacent said first outlet thereof for receiving said first portion of said primary stream from said first outlet of said first heat exchanger.

16. A duplex exchanger according to claim 15 wherein said second heat exchanger further includes a third inlet adjacent said first inlet thereof for receiving said second portion of said primary stream from said second outlet of said first heat exchanger.

17. A duplex exchanger according to claim 4 wherein:

said first and second heat exchangers include a common stack of plates;

each of said plates including a bank of first tubes integral therewith and collectively defining said first main channel, and said first counterheat channel being defined between said plates outside said first tubes; and

each of said plates further includes a bank of second tubes integral therewith correspondingly defining said second main channel, and said second counterheat channel being defined between said plates outside said second tubes.

18. A duplex exchanger according to claim 17 wherein:

said first tubes have common inlets at a forward end of said plates, and discrete outlets at opposite ends of said plates providing flow communication to said first and second counterheat channels between said plates; and

said second tubes have common inlets at said plate forward ends, and common outlets at said plate aft ends.

19. A duplex exchanger according to claim 18 further comprising a septum separating said banks of first and second tubes from each other, and also separating said first and second counterheat channels between said plates.

20. A duplex exchanger according to claim 19 wherein said coolant and saturant injecting means are configured to inject said coolant and saturant between said plates outside said first and second tubes therein.

21. A duplex exchanger according to claim 4 wherein:

said first and second heat exchangers include a stack of alternating first and second plates;

each of said plates including a partition collectively defining said first and second main channels between alternating pairs of said plates, and said first and second counterheat

channels being defined between different alternating pairs of said plates;

each of said first plates further includes an inlet at a forward end for said first main channel, and an outlet at an opposite aft end for said first main channel disposed in flow communication with both said first and second counterheat channels, another inlet at said forward end for said second main channel, and another outlet at said aft end for said second main channel; and

each of said second plates further includes an outlet at a forward end for said first and second counterheat channel .

22. A duplex exchanger according to claim 21 wherein said first and second plates further include complementary corrugations adjoining each other inside surrounding perimeter seals to further define said first and second main channels and said first and second counterheat channels between said alternating plates.

23. A duplex exchanger according to claim 21 wherein said coolant and saturant injecting means commonly inject a cooling and saturating fluid into said first and second counterheat channels downstream of said outlets in said first plates joining said first main channel with said first and second counterheat channels.

24. A duplex exchanger according to claim 23 further comprising a septum seal disposed at least in part between said first and second plates to separate said first and second counterheat channels.

25. A method for saturating a hot primary gas stream comprising:

channeling said primary stream through a first main channel;

channeling a hot secondary fluid stream through a second main channel;

splitting said primary stream discharged from said first main channel to flow in a first counterheat channel adjoining said first main channel and in a second counterheat channel adjoining said second main channel;

injecting an evaporative fluid into said first counterheat channel to evaporatively cool

said primary stream flowing through said first main channel; and

injecting an evaporative fluid into said second counterheat channel to saturate said primary stream flowing therethrough.

26. A method according to claim 25 further comprising discharging said primary stream from said first counterheat channel into an intermediate stage of said second counterheat channel.

27. A method according to claim 26 further comprising:

evaporatively cooling said primary stream in said first main channel for lowering the wet bulb temperature thereof toward the dew point temperature of the incoming primary stream; and

saturating said primary stream in said first counterheat channel to the wet bulb temperature of said cooled primary stream discharged from said first main channel.

28. A method according to claim 27 further comprising heating said cooled primary stream in said first counterheat channel by said hot primary stream in said first main channel for raising the dew point temperature thereof and saturating said primary stream therein.

29. A method according to claim 28 further comprising evaporating said evaporative fluid in said primary stream in said second counterheat channel and thereby cooling said secondary stream in second main channel toward the wet bulb temperature of said primary stream in said second counterheat channel.

30. A method according to claim 29 further comprising heating said cooled primary stream in said second counterheat channel by said hot secondary stream in said second main channel for increasing the wet bulb temperature and saturation thereof.

31. A method according to claim 30 further comprising:

injecting said evaporative fluid along an initial stage of said second counterheat

channel; and

superheating said primary stream in said second counterheat channel downstream of said initial stage using heat from said secondary stream channeled through said second main channel.

32. A method according to claim 30 further comprising:

injecting said evaporative fluid along an initial stage of said first counterheat channel; and

superheating said primary stream in said first counterheat channel downstream of said initial stage using heat from said main stream channeled through said first main channel.

33. A method according to claim 30 further comprising injecting excess evaporative fluid into said first counterheat channel for cooling thereof, and removing said cooled excess evaporative fluid from said first heat exchanger.